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EXAMINER	
DICKEY, THOMAS L	
ART UNIT	**PAPER NUMBER**
2826	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/772,573	MAWST ET AL.	
	Examiner	Art Unit	
	Thomas L. Dickey	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 July 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-67* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *27-38* is/are allowed.

6)☒ Claim(s) *1-21,23-26,39-46,48-52,55,56 and 64-67* is/are rejected.

7)☒ Claim(s) *22,47,53,54 and 57-63* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 February 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1)☐ Notice of References Cited (PTO-892)

2)☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3)☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4)☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5)☐ Notice of Informal Patent Application (PTO-152)

6)☐ Other: _____.

DETAILED ACTION

1. The amendment filed on 07/12/06 has been entered.

2. The rejection mailed 10/12/06 erroneously classified claims 27-38. These claims should have been indicated allowable. This paper corrects that error and sets a new time to respond.

Double Patenting

3. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting

ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1,2,8,11,12,15, 16-21,23-26,39,41,42,48,49, and 52 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-33 of U.S. Patent No. 6,791,104 in view of PETER ET AL. ("Light-emitting diodes and laser diodes based on a $Ga_{1-x}In_xAs/GaAs_{1-y}Sb_y$" Applied Physics Letters, 04/05/99, Vol. 74 Issue 14, pp1951-1953).

With regard to claims 1,2,8,11,12, and 15 claims 1-33 of Patent No. 6,791,104 disclose an optoelectronic device comprising a multilayer semiconductor structure including a substrate and an active region, the active region comprising at least a hole quantum well layer of a semiconductor containing antimony and at least one electron quantum well layer adjacent to the hole quantum well layer which comprises a semiconductor containing nitrogen to provide a type II quantum well structure, wherein the semiconductor containing antimony is InGaAsSb and the semiconductor containing nitrogen is InAsN, wherein the semiconductor containing antimony is GaAsSb or InGaAsSb and the semiconductor containing nitrogen is InAsN or InGaAsN, wherein the

electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other each having electron quantum well layers surrounding a hole quantum well layer, including means for providing optical feedback to form an edge-emitting laser or a vertical cavity surface-emitting laser.

Claims 1-33 do not disclose that the substrate is an InP substrate. However, Peter et al. discloses an optoelectronic device with an InP substrate. Note the first column of page 1951 of Peter et al. Peter et al. explain that the binary InP substrate is advantageous in that it is commercially used and thus technically advanced, has good thermal conductivity and low electrical resistance. Therefore, it would have been obvious to a person having skill in the art to replace the substrate of the device of claims 1-33 with the InP substrate such as taught by Peter et al. in order to provide a substrate that is technically advanced, has good thermal conductivity and low electrical resistance to thus provide higher reliability.

With regard to claims 16-21 and 23-26, claims 1-33 of Patent No. 6,791,104 disclose an optoelectronic device comprising a multilayer semiconductor structure including a substrate and an active region, the active region comprising at least a hole quantum well layer of GaAsSb or InGaAsSb and an electron quantum well layer of InAsN or InGaAsN on each side of the hole quantum well layer to provide a type II quantum well

structure, wherein the electron quantum well layers are in compressive strain and the hole quantum well layer is in compressive strain and the thickness of each electron quantum well layer and hole quantum well layer is between approximately 10 and 50 angstroms, wherein the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other and the electron quantum well layer is an InAsN layer, wherein the hole quantum well layer is an InGaAsSb layer and the electron quantum well layer is an InAsN layer, and including means for providing optical feedback to form an edge-emitting laser or a vertical cavity surface-emitting laser.

Claims 1-33 do not disclose that the substrate is an InP substrate. However, Peter et al. discloses an optoelectronic device with an InP substrate. Note the first column of page 1951 of Peter et al. Peter et al. explain that the binary InP substrate is advantageous in that it is commercially used and thus technically advanced, has good thermal conductivity and low electrical resistance. Therefore, it would have been obvious to a person having skill in the art to replace the substrate of the device of claims 1-33 with the InP substrate such as taught by Peter et al. in order to provide a substrate that is technically advanced, has good thermal conductivity and low electrical resistance to thus provide higher reliability.

With regard to claims 39,41,42,48,49, and 52, claims 1-33 of Patent No. 6,791,104 disclose an semiconductor laser comprising (a) a multilayer semiconductor structure including a substrate and an active region, the active region comprising at least a hole quantum well layer of a semiconductor containing antimony and at least one electron quantum well layer comprising a semiconductor containing nitrogen adjacent to the hole quantum well layer to provide a type II quantum well structure; and (b) means for providing optical feedback to provide lasing action in the active region, wherein the means for providing optical feedback forms an edge-emitting laser or a vertical cavity surface-emitting laser, wherein the electron quantum well layers are in compressive strain and the hole quantum well layer is in compressive strain and wherein the semiconductor containing antimony is InGaAsSb and the semiconductor containing nitrogen is InGaAsN.

Claims 1-33 do not disclose that the substrate is an InP substrate. However, Peter et al. discloses an optoelectronic device with an InP substrate. Note the first column of page 1951 of Peter et al. Peter et al. explain that the binary InP substrate is advantageous in that it is commercially used and thus technically advanced, has good thermal conductivity and low electrical resistance. Therefore, it would have been obvious to a person having skill in the art to replace the substrate of the device of claims 1-33 with the InP substrate such as taught by Peter et al. in order to provide a substrate

that is technically advanced, has good thermal conductivity and low electrical resistance to thus provide higher reliability.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

A. Claims 1,2,5,8,11-16,18,21,24,25,26,39-41,43-46,48-51, and 64-67 are rejected under 35 U.S.C. 103(a) as being unpatentable over PETER ET AL. ("Light-emitting diodes and laser diodes based on a $Ga_{1-x}In_xAs/GaAs_{1-y}Sb_y$" Applied Physics Letters, 04/05/99, Vol. 74 Issue 14, pp1951-1953), in view of Major et al. (5,689,123).

With regard to claims 1,2,8, 11-14, 54, and 66 Peter et al. disclose a multilayer semiconductor structure including an InP substrate and an active region, the active region comprising at least a hole quantum well layer of a semiconductor containing antimony and at least one electron quantum well layer adjacent to the hole quantum well layer which comprises a first semiconductor to provide a type II quantum well structure, wherein the first semiconductor comprises InAs, the semiconductor containing antimony is GaAsSb or InGaAsSb and the first semiconductor comprises InAs or

InGaAs, the electron quantum well layers are in compressive strain and the hole quantum well layer are in tensile strain, the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other each having electron quantum well layers surrounding a hole quantum well layer, and the active region generates light including means for providing optical feedback to form an edge-emitting laser or a vertical cavity surface-emitting laser.

With further regard to claims 39,40,41,43-46,48-51, 63-65, and 67 Peter et al. disclose a semiconductor laser including (a) an InP substrate and an active region, the active region comprising at least a hole quantum well layer of a semiconductor containing antimony and at least one electron quantum well layer comprising a first semiconductor adjacent to the hole quantum well layer to provide a type II quantum well structure; wherein there is an electron quantum well layer on each side of the hole quantum well layer and there is a barrier layer adjacent to each electron quantum well layer on each side of the hole quantum well layer to provide a conduction band profile for the active region having a W-shaped configuration, the semiconductor containing antimony is GaAsSb or InGaAsSb and the first semiconductor comprises InAs or InGaAs, wherein the electron quantum well layers are in compressive strain and the hole quantum well layer is in tensile strain, the thickness of each electron quantum well

layer and hole quantum well layer is between approximately 10 and 50 angstroms, the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other each having electron quantum well layers surrounding a hole quantum well layer, the first semiconductor comprises InAs, and wherein there is an optical confinement layer adjacent to each barrier layer, the optical confinement layer comprising InP, and (b) means for providing optical feedback to provide lasing action in the active region, the means for providing optical feedback forming an edge-emitting laser or a vertical cavity surface-emitting laser.

With regard to any of the above listed claims (1,2,5,8, 11-14, 54, and 66, 39,40,41,43-46,48-51, 63-65, and 67) the only difference between said claims and the device disclosed by Peter et al. is that Peter et al. does not disclose that the first semiconductor comprising InAs is a semiconductor containing nitrogen, in fact comprising InAsN, or that the active region generates light having a wavelength greater than approximately 2 microns or approximately 3 microns. In her paper filed 12/19/05, Applicant admits that these are the only differences.

However, Major et al. discloses a semiconductor laser with an electron quantum well layer comprising InAsN. Note figures 3-7 and column 11 lines 3-18 of Major et al. Major et al. teaches that adding as little as 4% nitrogen to $In_{.75}Ga_{.25}As$ (lattice matched to InP)

while making minor adjustments to the In/Ga ratio to retain lattice match, produces a layer, with a band gap of .53 ev or less, which lases at 2-3 microns, making it useful for LIDAR systems. Furthermore, according to Major et al., strain on such a layer is reduced by the introduction of nitrogen, further reducing the effective laser wavelength. Therefore, it would have been obvious to a person having skill in the art to replace the InAs of the first semiconductor of Peter et al.'s semiconductor laser with the InAsN such as taught by Major et al. in order to reduce band gap and strain, increasing effective laser wavelength to thus provide a laser capable of lasing at 2-3 microns, effective for LIDAR applications.

With regard to claims 16,18,20,21,24,25,26, and 59 Peter et al. disclose a multilayer semiconductor structure including an InP substrate and an active region, the active region comprising at least a hole quantum well layer of GaAsSb or InGaAsSb and an electron quantum well layer comprising InAs or InGaAs on each side of the hole quantum well layer to provide a type II quantum well structure, wherein the electron quantum well layer comprises a InAs layer, the thickness of each electron quantum well layer and hole quantum well layer is between approximately 10 and 50 angstroms, the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages

adjacent to each other, and including means for providing optical feedback to form an edge-emitting laser or a vertical cavity surface-emitting laser.

With regard to claims 27,28,29,32, and 34-38 Peter et al. disclose a multilayer semiconductor structure including an InP substrate and an active region, the active region comprising at least a hole quantum well layer of GaAsSb and an electron quantum well layer comprising InAs on each side of the hole quantum well layer to provide a type II quantum well structure wherein (at least one of) the electron quantum well layers is lattice matched to InP, the thickness of each electron quantum well layer and hole quantum well layer is between approximately 10 and 50 angstroms, the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other, and including means for providing optical feedback to form an edge-emitting laser or a vertical cavity surface-emitting laser.

With regard to any of the above listed claims (16,18,20,21,24,25,26, and 59, 27,28,29,32, and 34-38) the only difference between said claims and the device disclosed by Peter et al. is that Peter et al. does not disclose that the electron quantum well layer comprising InAs further comprises nitrogen so that it comprises InAsN. In her paper filed 12/19/05, Applicant admits that this is the only difference.

However, Major et al. discloses a semiconductor laser with an electron quantum well layer comprising InAsN. Note figures 3-7 and column 11 lines 3-18 of Major et al. Major et al. teaches that adding as little as 4% nitrogen to $In_{.75}Ga_{.25}As$ (which is the InGaAs alloy, comprising InAs, that is lattice matched to InP) while making minor adjustments to the In/Ga ratio to retain lattice match, produces a layer with a band gap of .53 ev or less, which lases at 2-3 microns, making it useful for LIDAR systems. Furthermore, according to Major et al., strain on such a layer is reduced by the introduction of nitrogen, further reducing the effective laser wavelength. Therefore, it would have been obvious to a person having skill in the art to replace the InAs of the first semiconductor of Peter et al.'s semiconductor laser with the InAsN such as taught by Major et al. in order to reduce band gap and strain, increasing effective laser wavelength to thus provide a laser capable of lasing at 2-3 microns, effective for LIDAR application.

B. Claims 1,3-10, 55, and 56 stand rejected under 35 U.S.C. 103(a) as being unpatentable over DAPKUS (6,621,842) in view of PETER ET AL. ("Light-emitting diodes and laser diodes based on a $Ga_{1-x}In_xAs/GaAs_{1-y}Sb_y$" Applied Physics Letters, 04/05/99, Vol. 74 Issue 14, pp1951-1953).

With regard to claims 1,3-7, 55, and 56 Dapkus discloses an optoelectronic device comprising a multilayer semiconductor structure including an substrate and an active region, the active region comprising at least a hole quantum well layer of a

semiconductor containing antimony and at least one electron quantum well layer adjacent to the hole quantum well layer which comprises a semiconductor containing nitrogen to provide a type II quantum well structure, wherein the semiconductor containing antimony is GaAsSb or InGaAsSb, there is an electron quantum well layer on each side of the hole quantum well layer and there is a GaInP barrier layer adjacent to each electron quantum well layer on each side of the hole quantum well layer to provide a conduction band profile for the active region having a W-shaped configuration. Note figures 2-4, column 5 lines 1-67, column 6 lines 1-67, and column 7 lines 1-29 of Dapkus.

Dapkus does not disclose that the substrate is an InP substrate. However, Peter et al. discloses an optoelectronic device with an InP substrate. Note the first column of page 1951 of Peter et al. Peter et al. explain that the binary InP substrate is advantageous in that it is commercially used and thus technically advanced, has good thermal conductivity and low electrical resistance. Therefore, it would have been obvious to a person having skill in the art to replace the substrate of the device of Dapkus with the InP substrate such as taught by Peter et al. in order to provide a substrate that is technically advanced, has good thermal conductivity and low electrical resistance to thus provide higher reliability.

With regard to claims 1,8,9, and 10 Dapkus discloses an optoelectronic device comprising a multilayer semiconductor structure including an substrate and an active region, the active region comprising at least a hole quantum well layer of a semiconductor containing antimony and at least one electron quantum well layer adjacent to the hole quantum well layer which comprises a semiconductor containing nitrogen to provide a type II quantum well structure, wherein the electron quantum well layers and hole quantum well layer form a first quantum well stage, and wherein the active region comprises a plurality of quantum well stages adjacent to each other each having electron quantum well layers surrounding a hole quantum well layer, and including a GaInP barrier layer between each quantum well stage to provide a conduction band profile having a W-shaped configuration. Note figures 2-4, column 5 lines 1-67, column 6 lines 1-67, and column 7 lines 1-29 of Dapkus.

Dapkus does not disclose that the substrate is an InP substrate. However, Peter et al. discloses an optoelectronic device with an InP substrate. Note the first column of page 1951 of Peter et al. Peter et al. explain that the binary InP substrate is advantageous in that it is commercially used and thus technically advanced, has good thermal conductivity and low electrical resistance. Therefore, it would have been obvious to a person having skill in the art to replace the substrate of the device of Dapkus with the InP substrate such as taught by Peter et al. in order to provide a

substrate that is technically advanced, has good thermal conductivity and low electrical resistance to thus provide higher reliability.

Response to Arguments

5. Applicant's arguments filed 7/12/06 have been fully considered but they are only partially persuasive.

On pages 11-12 of the remarks, Applicants continue to insist that the instant invention, if not simply too complex for a person of ordinary skill in the art (PHOSITA) to comprehend, is at least so complex that PHOSITA would be frightened away by its complexity. Specifically Applicants state:

> Each of the rejected claims recites an optoelectronic device that includes a hole quantum well layer containing antimony and an electron quantum well layer containing nitrogen built on an InP substrate. As noted by the Examiner, antimony-containing hole quantum well layers, nitrogen-containing electron quantum well layers and InP substrates are each individually known in the art. However, in light of the unpredictable nature of semiconductor based optoelectronic devices, the prior art does not provide motivation to select these individual components from different prior art devices and combine them into a single, functioning, optoelectronic device. As one of ordinary skill in the art would recognize, the building of a functional semiconductor-based optoelectronic device is no simple feat. Although the chemical and physical properties of each individual material in the device might be well characterized, the properties and behavior of the materials combined in a semiconductor stack is not easily predicted. Just a few of the many properties of the materials that have an effect on their ability to provide a functioning optoelectronic device (and the emission properties of any resulting device) include lattice mismatch and lattice strain, conduction band offsets, refractive index contrasts and relative thermal and electrical conductivities. Based on the complicated interplay between these and other material properties, it would be unreasonable to assume that one could just mix and match the semiconductor layers from different devices and come up with a functioning optoelectronic device. Thus, at best, the prior art cited by the Examiner invites the reader to try each of numerous possible substrates, hole quantum well layers and electron quantum well layers until he possibly produces an operational optoelectronic device. However, any rejection of the claims based on such a general invitation would involve the application of an improper "obvious to try" rationale. (MPEP 2145)

It is Applicants' position that PHOSITA, although motivated to try to achieve the claimed invention, would not have been assured of achieving success, because PHOSITA would have been unable to perform the "calculations necessary to simulate the claimed devices in order to determine which systems would provide an operational optoelectronic device." Specifically applicants state:

> In the present application, the inventors have done much more than simply mix and match semiconductor layers from different optoelectronic devices in the blind hope of producing a functioning optoelectronic device. As described in paragraphs 0028 and 0029 and illustrated in FIGS. 1-4 of the specification, the inventors performed the calculations necessary to simulate the claimed devices in order to determine which systems would provide an operational optoelectronic device. These calculations were needed to assess the properties of the systems based on the energy bandgap dependence on material composition, strain induced bandgap shifts, quantum confined states, carrier densities and optical response functions, among other factors. This information was used to determine what material compositions and thicknesses were needed for a given substrate. As one of ordinary skill in the art would recognize, such calculations and simulations are far from routine or trivial.

Paragraphs 0028 and 0029 and illustrated in FIGS. 1-4 of the instant specification read as follows:

> [0027] In accordance with the invention, rather than employing type-I InGaAsN quantum wells (QWs) with high N-content, longer wavelengths may be accessed more readily via type-II InAsN/GaAsSb or InGaAsN/GaAsSb structures. The energy gap in a type-II structure is governed primarily by the relative conduction and valence band alignments in the two adjacent layers rather than by the bulk gap in a single layer. The resulting flexibility comes at the expense of reduced overlap between the electron and hole wave functions that now peak in different layers. In the midwave-infrared (3-5 .mu.m) spectral range, the so-called "W" structure is utilized, in which two electron QWs sandwich a single hole QW to maximize the type-II wave function overlap and hence the differential gain. The electron QWs are in turn bounded by barrier layers that confine both carrier types. See J. R. Meyer, C. A. Hoffman, F. J. Bartoli, and L. R. Ram-Mohan, "Type II-quantum well lasers for the mid-wavelength infrared," Appl. Phys. Lett., 67 (6), 1995, pp. 757-759. To achieve mid-IR (2-5 .mu.m) operation from such a "W" structure, in the present invention a novel dilute-nitride type-II QW design is implemented utilizing an InP substrate. A preferred but not limiting range of nitrogen content for the electron quantum wells is 10% or less.
>
> [0028] For purposes of illustrating the invention, the band diagram for one period, or stage, of an example of an optoelectronic device with an approximate 0.30-eV energy gap (λ=4.1 μm emission) at room temperature is shown at 10 in FIG. 1. This device is provided for example only, and it is understood that the invention is not limited to this example. Each of the two $InAs_{0.97}N_{0.03}$ (2.6%

> compressive strain) electron QWs 12 are 12 angstroms thick, and the single $GaAs_{0.35}Sb_{0.65}$ (1.2% compressive strain) hole QW 14 is 20 angstroms thick. Such a structure, in which two electron QWs surround a hole QW and two barrier layers 16 surround the electron QWs so as to maximize the wave function overlap, is referred to as a type II "W" configuration because of the shape of the conduction band profile. The advantages of the W configuration are discussed in J. R. Meyer, C. A. Hoffman, F. J. Bartoli, and L. R. Ram-Mohan, "Type II-quantum well lasers for the mid-wavelength infrared," Appl. Phys. Lett., 67 (6), 1995, pp. 757-759. See, also U.S. Pat. No. 5,793,787. In FIG. 1, the InAsN electron QWs 12 are surrounded by In.sub.0.75Ga.sub.0.25P (1.8% tensile strained) barriers 16 (130 angstroms thick), which provide strain compensation. Since adequate hole confinement often becomes an issue when type-I GaAsN and InGaAsN active regions are employed, the strong confinement of both carrier types here represents an additional advantage of the type-II approach. The curves 17 and 18 in FIG. 1 illustrate the spatial profiles of the ground-state electron and hole wave functions, respectively. Energy dispersion relations, wave functions, and optical matrix elements were calculated for the device of FIG. 1 using a 10-band k dot p formalism. The band anti-crossing (BAC) model was employed to incorporate a spin-degenerate nitrogen-like band that accounts for the interaction of Γ-like and N-like states in the dilute-nitride layers. Band parameters for the non-nitride and dilute-nitride materials are taken from I. Vurgaftman and J. R. Meyer, "Band parameters for nitrogen-containing semiconductors," J. Appl. Phys. 94, 3675 (2003).

The only "calculations and simulations" applicants disclose in these paragraphs is that the "band anti-crossing (BAC) model was employed [using] band parameters [from] Vurgaftman and Meyer, ... (2003)."

The band anti-crossing (BAC) calculational model was developed in the late 20th century by a group of scientists working at the Materials Sciences Division, Lawrence Berkeley National Laboratory, as is evident from, for example, Shan et al., "Band Anticrossing in GaInNAs Alloys," Phys. Rev. Lett. Vol. 82, No. 6, pp 1221-1224 (1999), and "Striking Effects Of Nitrogen In Semiconductor Alloy Explained," Press Release, Lawrence Berkeley National Laboratory, June 9, 1999.

The band anti-crossing (BAC) calculational model was available to PHOSITA as prior art. Band parameters for the non-nitride and dilute-nitride materials were available to PHOSITA as prior art in Vurgaftman and J. R. Meyer, "Band parameters for nitrogen-

containing semiconductors," J. Appl. Phys. 94, 3675 (2003). Applicant's argument that as "one of ordinary skill in the art would recognize, such calculations and simulations are far from routine or trivial," thus boils down to an argument that PHOSITA would not have displayed the gumption Applicants employed to crank through the complexities of the Berkeley group's BAC model (using the specific data supplied by Vurgaftman et al.) to arrive at the claimed invention.

The Examiner's position, on the other hand, is the STM test does not require a factual finding of "gumption" on the part of PHOSITA. Rather, a "reasonable expectation of success," is found when a reasonably clear pathway to success is suggested by the prior art as a whole. That the suggested pathway to success may be painful, time-consuming, expensive, complicated, or mind numbing, is immaterial to a finding of a reasonable expectation of success.

On page 13 Applicants argue, "Applicants respectfully submit that claims 27, 54, 59 and 63 clearly recite an electron quantum well layer of InAsN and not an electron quantum well layer of InGaAsN." It remains the Examiner's (unproven) belief that a "well" of "pure" ternary InAsN, formed over InP, would necessarily have to have a lattice constant close to that of InP (pure InAs has a lattice constant of 6.0583 angstroms, 3%

greater than InP's lattice constant of 5.8687[1] angstroms), or else be full of cracks, voids, discontinuities and "slip" in general. Producing such a lattice constant would require adjusting the N content (there being nothing in a ternary compound to adjust but the relative content of As and N) to the point where the band gap of said compound would go negative (metallic). See figure 2 of Harris et al.

However, Applicants have made it clear that absolutely no gallium is allowed in the wells of claims 27, 54, 59 and 63. On this understanding, there being no "smoking gun" of non-enablement, claims 27, 54, 59 and 63 are allowable.

Allowable Subject Matter

6. Claims 27-38 are allowed over the references of record because none of these references disclosed or can be combined to yield the claimed invention such as an optoelectronic device comprising a multilayer semiconductor structure including, at a minimum, a pair of electron quantum well layers, in compressive strain, having the formula InAsN (no gallium, for example, is allowed, as applicants point out on pp 13-14 of their paper dated 7/12/06) as recited in claim 27.

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[1] Lattice constants from Madelung, Otfried (Ed.) *Semiconductors – Basic Data,* Springer-Verlag, Berlin, 1996

7. Claims 22, 47,53,54 and 57-63 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

8. THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thomas L Dickey whose telephone number is 571-272-1913. The examiner can normally be reached on Monday-Thursday 8-6.

If attempts to reach the examiner by telephone are unsuccessful, please contact the examiner's supervisors, Wael M Fahmy (571-272-1705) or Robert J. Pascal (571-272-1769). The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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Art Unit 2826